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### DR. G. E. F. LUNDELL BECOMES CHIEF OF CHEMISTRY DIVISION

The appointment of Dr. G. E. F. Lundell as Chief of the Bureau's Chemistry Division to fill the vacancy caused by the retirement of Percy H. Walker was announced on September 22 by Dr. Lyman J. Briggs, Director of the Bureau.

Dr. Lundell is internationally known for his many contributions to precise analytical methods and is the author of numerous papers in this field. He was born in Brooklyn, N. Y., January 11, 1881, and attended the public schools. He received his A. B. degree from Cornell University in 1903. Six years later he was awarded his Ph. D. from the same institution.

From 1910 until 1917 Dr. Lundell served as Assistant Professor of Analytical Chemistry at Cornell. He came to the Bureau as associate chemist on

July 5, 1917. Since 1919 he has had charge of the section of metal and ore analysis and standard samples, and for the past year and a half has also served as Assistant Chief of the Division.

Dr. Lundell will be succeeded as Assistant Chief of the Division by Dr. C. E. Waters, who has for many years been in charge of the section on organic chemistry.

### INTERNATIONAL COMMITTEE ON WEIGHTS AND MEASURES

The International Committee on Weights and Measures held its regular biennial meeting at Sevres and Paris, France, June 23 to 29, 1937. Its most important actions were further steps toward the introduction of electrical units based upon absolute measurements; that is, derived directly from the fundamental mechanical units; and

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a decision to establish a new system or photometric units to supersede the two systems now in use in different countries. Both of these changes are intended to take effect January 1, 1940.

National laboratories in several countries are making experimental determinations of the absolute values of the electrical units. The results of such determinations are brought together at the International Bureau of Weights and Measures in the form of values assigned to standard cells and ohm standards sent from the National laboratories. In establishing the units on the new basis all such determinations reported before the end of 1938 will be considered.

In 1935 the International Committee issued a table of the ratios existing between the present International units and the corresponding absolute units, stated to four decimal places. (Technical News Bulletin 225; January 1936). Determinations now reported seem to justify an estimate carried one decimal place further, so that manufacturers of high-precision standards and others interested can prepare for

the change of units. Accordingly, the International Committee now gives the following probable relations:

**1 Mean International Ohm=1.000 48  
Absolute Ohms.**

**1 Mean International Volt=1.000 36  
Absolute Volts.**

The first of these values appears to be exact to two or three units in the last place given; the second to a few units in that place.

The "Mean International" Ohm and Volt are the means of the units maintained by six National laboratories, starting from the values found in 1935 as a base. At that time the French laboratory adopted the mean of the other five, and since then the Russian laboratory has adjusted its units to the mean. There has also been a slight drift of relative values. As a result of comparisons made in December 1936 and January 1937, the International Bureau reports the following departures of the units of the several countries from the mean units, as established in 1935.

*Departure of national units from mean international ohm and volt*

[In parts per million]

Country	In 1935		In 1936-37	
	Ohm	Volt	Ohm	Volt
France.....	(1)	(1)	+1	+1
Germany.....	+10	-4	+7	-7
Great Britain.....	-4	+5	-4	+8
Japan.....	-11	-2	-10	+1
USSR.....	+11	+13	0	-6
United States.....	-6	-12	-4	-10

<sup>1</sup> Adopted mean.

The new system of photometric units to be established will be derived from a primary standard proposed and developed by the National Bureau of Standards. This is a black-body radiator operated at the temperature of freezing platinum of specified purity. The magnitude of the units in the new system will be fixed by taking the brightness of the primary standard as exactly 60 candles per square centimeter.

For sources of light differing in color from the primary standard the photometric values will be determined by methods based upon the spectral luminosity factors (formerly called visibility factors) established at the Bureau in 1923 and since then adopted by various

national and international bodies. For the immediate purpose of calibrating incandescent lamps or secondary standards at temperatures above that of the primary standard, use will be made of blue filters which have been chosen to produce a color match in the photometric field when they are interposed between the photometer and the standard operating at the lower temperature.

In order to insure uniformity between countries in setting up the new standards, groups of lamps of each general type will be prepared by each National laboratory and sent to the National Physical Laboratory of Great Britain for comparison.

The units to be established will be called the "new candle", "new lumen",

etc., with appropriate translation into other languages, in the expectation that after a few years the adjective "new" will be dropped in ordinary use of the terms.

For a number of years the International Committee has had International Advisory Committees on Electricity and on Photometry, through which it obtains the advantages of organized collaboration with the several national standardizing laboratories and with individual experts in those special fields. It has now decided to form a similar Advisory Committee on Thermometry.

#### PORTABLE PHOTOELECTRIC TIMING APPARATUS

The timing of intervals of a few seconds to several minutes is usually done with a stop watch. Such measurements, although sufficiently exact for many purposes, are subject to errors because of variation in rate of the watch, errors in the starting and stopping of the indicating mechanism, and personal errors of the observer. In an attempt to measure the rate of flow of water with an accuracy of approximately 0.1 percent during short intervals, the need of more precise equipment was felt. A timer consisting of a photoelectric relay, a chronograph, and a chronometer was, therefore, constructed by F. C. Morey, of the Bureau's hydraulic laboratory.

The apparatus is arranged so that when the flow of water is diverted from the waste trough into the collecting tank a target on the diverter momentarily breaks a beam of light falling on the photocell. The photoelectric relay thus sends an electrical impulse to a pen on the chronograph. This causes a mark to appear on the moving paper tape. Continuous electrical time signals from the chronometer are received by another pen on the chronograph, making similar marks every half second on the same tape. It is thus possible to determine the number of seconds elapsed between successive breaks in the light beam, which, in turn, denote the starting and stopping of the collecting of water in the weigh tank.

Tests on the chronometer and chronograph by comparison with time signals from an astronomical clock of known rate showed that the signals from the chronometer did not depart from the former by more than 0.0498 second per hour and did not deviate from their average rate by more than 0.0158 second per hour. The chronometer thus provides a source of highly accurate time signals.

In actual use the timing equipment has made possible the determination of the rate of flow of water during intervals as short as 20 seconds with such a degree of precision that in 11 trials with a constant rate of flow the greatest deviation from the average rate amounted to only 0.13 percent.

Other advantages possessed by the timer are portability, adaptability to many time measurement problems, permanence of record, and elimination of the personal factor.

#### MEASUREMENT OF SUPERVOLTAGE X-RAYS

X-rays generated by voltages up to 200,000 volts have been actively used in this country and abroad since 1918 in the treatment of cancer, tumors, and other serious diseases. Much difficulty and confusion resulted in the early years from a lack of a suitable physical means to administer the doses in different hospitals. After years of research a suitable and coordinated system of dosage was established so that today X-rays, at these voltages, may be administered with a high degree of accuracy and safety. The Bureau, in cooperation with several similar foreign laboratories, has been instrumental in this work of establishing and maintaining X-ray standards.

Within the past 3 years X-ray voltages have been more than doubled, there being several dozen X-ray plants in this country operating at 400,000 volts and some half dozen at voltages from 600,000 to 1,200,000. With this increase in voltage entirely new measurement problems have arisen, the solution of which is awaited before these new radiations can be safely utilized to their ultimate limit. To meet this demand the Bureau has recently installed a 500-kv X-ray plant to provide a starting point on the problem, although it is generally recognized that ultimately it will be necessary to double that voltage to keep abreast of the clinical demand for X-ray standards.

To measure the X-rays a tube of special design has been so constructed as to avoid the difficulties of standardization ordinarily encountered in hospital installations. One of the world's largest X-ray ionization chambers has also been built with the view of measuring all X-rays from 100,000 to 1,000,000 volts. This chamber is of the so-called guarded field type and is contained in a large steel pressure cylinder capable of being operated up to 150 pounds per square inch (ten times atmospheric pressure). X-rays pass

into this through a thin window and render the air inside electrically conducting, a measure of which gives the X-ray intensity. By operating at the high pressures it is possible to avoid some of the main difficulties encountered in other methods. Measurements up to 400,000 volts have been carried out, and it appears possible for the first time to standardize accurately dosage up to these limits.

A paper presenting the results of this investigation was presented by Lauriston S. Taylor and George Singer, of the Bureau's staff, before the meetings of the Fifth International Congress of Radiology in Chicago, September 13-17.

#### STANDARDIZATION OF DENTAL MATERIALS

As a result of cooperative research between the Bureau and the American Dental Association, standards have been developed for nine dental materials. Lists of products which comply with these standards are furnished to dentists after the respective manufacturers have certified that their materials meet the standard requirements. Samples of all certified products are tested by research associates stationed at the Bureau to prevent improper use of the certification privilege.

Scientific research on dental materials has a direct relation to the health of the people of the United States, and the present program reaches from the manufacturer to the consumer and is mutually helpful to all concerned.

#### ELECTRICAL CHARACTER OF THE SPARK DISCHARGE OF AUTOMOTIVE IGNITION SYSTEMS

A knowledge of the electrical character of the spark which causes ignition in internal-combustion engines of the spark-ignition type is essential in evaluating its effect on the process of ignition, on the wear to which the component parts of the ignition system are subjected, and on the interference set up in radio receivers.

For examining the electrical character of the spark discharge the cathode-ray oscilloscope is unequalled. With this instrument it is possible, with proper precautions, to measure the instantaneous values of current and voltage throughout the cycle of a spark and so to determine its electrical characteristics.

In certain typical ignition circuits which have been investigated by Melville F. Peters, George F. Blackburn, and Paul T. Hennen, when the breakdown voltage at the spark gap was

about 10,000 volts, crest currents as high as 80 amperes were measured at frequencies up to 10 megacycles per second and rates of energy dissipation up to 60 kilowatts.

These quantities are dependent on the electrical constants of the spark generating system, and it is thus possible to predetermine their magnitudes, within limits, by adjustment of these constants.

A complete report of this work will be published as RP1032 in the October number of the Journal of Research.

#### RECOMBINATION OF IONS IN AFTERGLOW OF A CESIUM DISCHARGE

In the October number of the Journal of Research (RP1036), Fred L. Mohler describes experiments on the recombination of ions in the afterglow of a cesium discharge. A discharge through a 500-cm<sup>3</sup> bulb was short-circuited by a motor-driven commutator, and the radiation and electrical characteristics of the afterglow were studied. Radiation at a definite time interval after the cut-off was observed by means of a sectored disk on the commutator shaft, while electrical measurements were made by closing a probe circuit momentarily by a second commutator.

The afterglow was found to fade at a rate which decreases with increasing pressure up to 46  $\mu$  and remains nearly constant (the half-value time for a 6-ampere discharge was  $1.5 \times 10^{-3}$  sec) in the pressure range 46 to 110  $\mu$ . The spectral-intensity distribution of the continuous recombination spectrum indicates a much lower electron temperature than in the discharge, decreasing with time from 1,360°K at  $0.9 \times 10^{-3}$  sec to 1,200°K at  $1.7 \times 10^{-3}$  sec.

The number of ions at any time during the afterglow was measured by the positive-ion current to a negative probe, and the flow of ions to the wall was measured by the current to a collector against the bulb wall. The difference between the change in number of ions in the bulb and the flow of ions to the wall gives the number recombining in the space. From this was derived a recombination coefficient of  $3.4 \times 10^{-30}$  in the pressure range 10 to 30  $\mu$ .

#### TABLES OF WAVE LENGTHS FOR SPECTROCHEMICAL ANALYSIS

After many years of skepticism and neglect, applied spectroscopy is coming into its own. Five successive summer conferences at the Massachusetts Institute of Technology have shown continued and increasing interest in chemical analysis by spectroscopic methods, and it is estimated that such methods

are now employed by 200 research and industrial laboratories in this country.

The fundamental data of spectrum analysis consist of wave lengths and intensities of radiations emitted by atoms or molecules, since chemical identifications rest upon wave-length measurements and quantitative determinations are based on intensity comparisons.

Critical examination of the published tables of wave lengths and intensities, and experience in their practical use, soon convince one that these tables are not all that could be desired for modern spectrographic analysis. Thus far, all condensed tables have been based either on spark spectra of solutions or on arbitrary selections of lines from complete tables, and no convenient, homogeneous, up-to-date compilation of the latter exists. In all cases the relative intensities are on arbitrary, inadequate scales.

New tables of partial or residual spectra are being prepared at the Bureau for the arc spectra of 60 or more elements, the selection being made by observing which lines persist at low concentrations, and the relative intensities being derived from observed persistence and controlled by theoretical intensity ratios.

During the discussion of a paper on this subject by William F. Meggers at the recent conference on spectroscopy held at the Massachusetts Institute of Technology, it was announced that the MIT-WPA program of wave-length and intensity measurements promises new and homogeneous data for arc and spark spectra of 50 or more elements. The spectral range now being measured is from 1,000 to 10,000 Å. A condensed table of about 100,000 principal lines is projected. This will be followed eventually by complete descriptions of all atomic-emission spectra, which will comprise more than 1,000,000 lines.

#### MUTAROTATION OF *l*-SORBOSE

In the October number of the Journal of Research (RP1035), William W. Pigman and Horace S. Isbell report optical-rotation measurements on carefully purified *l*-sorbose at 20 and 0° C. In contradiction of the statements in various periodicals and textbooks, their results show that this sugar exhibits a small complex mutarotation.

#### ESTIMATION OF AMINO NITROGEN IN INSOLUBLE PROTEINS

The basic amino acids, which are of primary importance in proteins, appear to be held in the protein chains by peptide linkages involving their carboxyl and  $\alpha$ -amino groups. Presumably the remaining basic groups are free in the native protein, and, as a result, they have been related to the combining of various proteins with acids, dyes, and tannins. Completely satisfactory conclusions on the nature of such combinations have not been obtained because of the lack of suitable methods for the quantitative estimation of free-amino groups in proteins.

In an earlier investigation at the Bureau it was found that the rate of evolution of nitrogen from a protein during treatment with nitrous acid appeared to be of some significance. Since the method, with the original apparatus, was time-consuming, a new apparatus was developed by Henry A. Rutherford, Milton Harris, and Arthur L. Smith and is described in RP1038 in the October number of the Journal of Research.

Examination of the rate curves of a number of proteins indicates that there is a primary reaction with a relatively rapid evolution of nitrogen, followed by a secondary reaction in which the nitrogen is evolved much more slowly and at an approximately constant rate. Extrapolation of the straight line portions of the curves to zero time gives values which appear to be good estimates of the amino-nitrogen contents of the proteins.

#### SEPARATION OF THE THREE METHYL OCTANES FROM MIDCONTINENT PETROLEUM

The isolation of the three methyloctanes from petroleum has been accomplished for the first time by Joseph D. White and Augustus R. Glasgow, Jr., of the Bureau's Chemistry Division. The work is a continuation of that on the separation, identification, and determination of the constituents of petroleum, sponsored by the American Petroleum Institute as its Research Project 6.

The methyloctanes were found closely associated with naphthenic hydrocarbons in the fraction of Oklahoma petroleum which distilled between 142 and 145° C. after the aromatic hydrocarbons had been removed. Together they constitute about 0.3 percent of the crude, the 2-, 3-, and 4-methyloctane being present in the proportions of 3, 1, and 1.

In all, the methyloctane fraction contained not less than seven compounds. These have been separated from one another by physical means alone. *c*-Xylene was extracted with liquid sulphur dioxide and silica gel, the naph-

thenes were removed by distillation either at reduced pressure or with admixture of glacial acetic acid. The residual paraffinic fraction yielded at once 2-methyloctane on crystallization from solvent dichlorodifluoromethane. Redistillation of the mother liquid produced concentrates of the 3- and 4-methyloctane which, because of their high viscosity when cooled, had to be crystallized from solvent methane, a liquid with very low viscosity, in order to separate them in a nearly pure condition.

The isolated methyloctanes were identified by their physical properties. Those obtained were boiling point, freezing point, density, refractive index, and critical solution temperature in aniline. A characteristic property of the 3- and 4-methyloctane was the pronounced undercooling required to induce them to crystallize. This phenomenon is associated with their optical isomerism. In such cases the presence of two varieties of molecules strongly militates against crystallization.

Thus far 5 of the 35 isomeric hydrocarbons having the formula  $C_9H_{20}$  have been isolated from the petroleum, namely, the 3 methyloctanes, *n*-nonane boiling at  $150.7^\circ C$ . and 2, 6-dimethylheptane boiling at  $135.2^\circ C$ . There are indications that a few other nonanes are present in detectable amounts, but the complete analysis of the petroleum will reveal only a fraction of the number which conceivably could be present.

RP1033 in the October number of the Journal of Research gives the official report of this work.

#### X-RAY DIFFRACTION PATTERNS OF RUBBER

RP1039 in the October number of the Journal of Research describes recent work by Prof. George L. Clark and Enno Wolthuis, of the University of Illinois, in cooperation with W. Harold Smith, of the Bureau's Chemistry Division, on the X-ray diffraction patterns of sol, gel, and total rubber when stretched and when crystallized by freezing and from solutions.

Ordinary unstretched rubber yields an X-ray diffraction pattern characteristic of a liquid or amorphous solid, but when stretched it produces the pattern of a fibrous crystalline material. If massive rubber is cooled to a low temperature but not stretched, it produces the pattern of a fibrous crystalline material. If massive rubber is cooled to a low temperature but not stretched, a hard opaque material is formed, which

also yields a crystalline X-ray diffraction pattern like that produced when rubber is stretched. The same pattern is also obtained from crystals of rubber which separate from ethereal solutions at low temperatures.

In the present investigation rubber has been separated into two parts, "sol" and "gel", by a method which avoids oxidation and structural changes. The sol composes about 75 percent, the gel about 25 percent, of the total rubber. When stretched, the sol rubber shows no evidence of crystallinity. The gel rubber, however, produces a crystal pattern which is well defined. The larger of the two fractions flows more readily under stress, or is more mobile than the smaller.

In the smaller fraction, unstretched, a large interplanar spacing was found, which is absent in the larger one. Its significance is not yet understood.

Because of the unique physical properties of rubber, its structure has been studied by many other investigators who have used X-rays. Each has contributed refinements of technique or new mathematical deductions. As a result, there has been a continued increase of the volume assigned to the unit cell of rubber. Within a year there has been a contribution by Lotmar and Meyer, in Switzerland, who have assigned to crystalline rubber a monoclinic structure. Barnes, in Canada, has checked the cell dimensions, and the results of the present investigation are also in excellent agreement with Lotmar and Meyer. Consequently the dimensions of the unit cell of rubber now appear to be fixed, and the identity of crystals grown by stretching, by cooling massive rubber, and by crystallization from cold solutions, has been established.

#### TRANSPARENT PLASTICS FOR AIR-CRAFT WINDOWS

The utilization of transparent synthetic plastics for windows has been the goal of many research workers because of the fragility and hazardous nature of glass. Cost considerations, as well as low scratch resistance, have limited the use of organic plastic windows to removable curtains for automobiles and wire-reinforced products with a high ultra-violet transmission. The aircraft industry, however, has stimulated the development of windshields from transparent plastics. These save half the weight and can be bent to conform to streamline design.

Cellulose nitrate (celluloid) and cellulose acetate, which has found an important application in transparent form

as safety or flame-resistant film, have both been used as aircraft windshields. The cellulose is usually obtained from cotton, but wood and stalks of wheat, corn, and other grains can be used. During 1936 a type of synthetic resin which can be made from alcohol or acetone was introduced in this country in transparent sheet form. Technically, these transparent resins are classed as esters of acrylic and methacrylic acids and are distantly related to glycerol.

The National Advisory Committee for Aeronautics established a project at the Bureau to study the suitability of synthetic resins and cellulose plastics for aircraft windshields. The following types of transparent plastics were found to be available commercially or experimentally: cellulose nitrate, cellulose acetate, cellulose acetobutyrate, ethylcellulose, acrylate and methacrylate esters, vinyl chloride-acetate, vinyl acetal, glyceryl phthalate, styrene, and phenol-formaldehyde. The behavior of these materials was determined with respect to light transmission; freedom from haze, surface imperfections, and constituents which reduce or distort vision; resistance to weathering and to surface abrasion; impact strength; dimensional stability; resistance to the action of water and cleaning fluids; bursting strength at normal and low temperatures; and flammability.

The results so far obtained in this investigation are given in RP1031, to be published in the Journal of Research for October. Cellulose acetate plastic was found to have excellent impact strength, bursting strength, and flexibility, but the commercial products tested varied considerably in resistance to weathering, and all were subject to marked shrinkage in 1 year's time. The shrinkage produces warping and sets up strains in the plastic sheets, which cause them to craze and crack. These strains are believed to be the cause of the spontaneous cracking of cellulose acetate windshields after they have been in service for 6 months or longer. This is particularly true of windshields exposed to the low temperatures encountered at high altitudes. A great deal of variation was observed in the weathering resistance between cellulose acetate sheets received from different manufacturers and also between different lots of the material from the same manufacturer.

The acrylate resin plastic was found to be remarkably transparent, more stable to light and weathering, and more resistant to scratching than cellulose acetate, but it is deficient in im-

pact strength and flexibility. Surface crazing of the acrylate resins was noted after one year of exposure outdoors, and also after storage for a similar period. It is claimed, however, that a method of processing has been developed which eliminates this tendency.

Other transparent plastics, such as cellulose nitrate, ethylcellulose, vinyl chloride-acetate resin, and vinyl acetal resins, failed in resistance to weathering after approximately three months. Glyceryl-phthalate, styrene, and phenol-formaldehyde resin plastics discolored markedly on exposure to sunlight or ultraviolet light from a carbon-arc lamp, and also lacked flexibility. A sample of cellulose acetobutyrate was practically unchanged after 12 months of exposure. With the exception of the cellulose nitrate, cellulose acetate, and acrylate resin plastics, the materials tested were of an experimental nature and were not recommended for use on aircraft. Many of the undesirable properties observed for these experimental materials will undoubtedly be eliminated in the course of development, and it is not improbable that some of them will later become available in a form suitable for windshield use.

Pending the results of further tests on samples of cellulose acetate, acrylate resin, and other plastics, which have been prepared by the manufacturers using modified compositions and methods of processing to overcome the defective behavior noted during the course of this investigation, it is concluded that the problem of choosing between cellulose acetate and acrylate resin plastics for aircraft windows at present appears to hinge on the required impact strength. If a relatively high strength is necessary, the cellulose acetate sheets are much superior to the acrylate resin. However, if this is not essential, then the superior clarity and weathering resistance of the acrylate resin makes it more desirable. Both the cellulose acetate and the acrylate resin have the advantages of being lighter in weight than glass and of being readily fitted to curved openings.

#### GLASS-LINED HYPO TANKS

In Technical News Bulletin 223 (November 1935) a reference was made to some studies of the action of hypo solutions on stone tanks frequently used in photographic shops. Unless a careful selection of the stone is made for such tanks, they are not apt to prove satisfactory because of the severe conditions arising from crystallization of the hypo

salts within the pores. A more complete description of the studies was published in J. Research NBS 16, 161 (February 1936) (RP864), in which a specification is suggested for obtaining suitable stone for this purpose. As the specification is necessarily quite stringent, there are only a limited number of materials available that will meet the requirements.

In view of these considerations, it was thought possible to design a tank that could be made at moderate cost, and for which it would be feasible to utilize a large variety of stone products. Hence a small test tank was designed by D. W. Kessler of slate, with a glass lining. The slabs were fastened together with bolts without any special effort to secure tight joints. Five sheets of double-thickness windowpane glass were then cut to fit the inside of the tank. These were sealed in place by heating the slate, the glass, and a high-melting asphalt to a temperature sufficient to reduce the asphalt to a thin consistency. The interior of the slate tank was then coated with the liquid asphalt and the glass slabs fitted in place. When the materials had cooled, the tank was put under test by filling half full of a standard hypo solution. It has now been exposed to the solution for one year and is still in perfect condition.

Slate was chosen for this purpose as being probably one of the most economical types of stone for such use. It is also a material that would show early disintegration where freely exposed to the action of hypo solution, hence it affords an excellent material upon which to conduct such a test. In order to obtain a comparison between the resistance of the slate under such conditions and the resistance of other materials freely exposed to the solution, several specimens were placed inside the tank partly in the solution and partly above. Most of these specimens have shown a large amount of decay or, in some cases, almost complete disintegration.

As suggested in the publications referred to above, stone hypo tanks are often coated with a bituminous paint on the inside which affords a satisfactory protection as long as the coating remains impermeable. However, when the solution once penetrates behind the coating it will soon disappear and hence renewal is necessary. In the glass-lined tank the bituminous material is exposed to the hypo solution only in the joints of the glass, and the above test has indicated that under

such conditions it will last for a considerable period of time.

Due to the fact that slate can be quite economically made in the form of slabs, it is believed that a glass-lined slate tank such as described above can be constructed at less cost than tanks of those varieties of stone which are resistant to hypo solution.

#### ESTIMATION OF PARTICLE-SIZE GRADATION

The importance of the effect of subsieve fineness on the properties of pulverized materials is becoming more generally recognized. For example, the covering power of mineral pigments and the rate of hardening of portland cement are now known to be dependent upon grain sizes much smaller than the meshes of the finest sieves. This knowledge and the realization of the necessity of closer control of the grinding processes, both for economy of operation and for uniformity of product, has resulted in an intensive investigation of methods of determining subsieve sizes.

J. R. Gran, of the Bureau's cement and concrete section, has compared the principal methods in use for the determination of particle size gradation, as follows: Microscopic measurement, sedimentation, elutriation. His work shows the inherently arbitrary nature of all such measurements. In addition, it appears that much of the disagreement between results of different methods is caused by differences in the basic assumptions—such as the definition of the diameter of a single particle and the calculation of an average diameter of a group of particles.

Two sedimentation methods, the hydrometer and turbidimeter, have been compared by actual tests on a portland cement, three puzzolanic materials, and three cements made by blending the above. These tests show that while the results of one method do not check those of the other, because of differences in interpretation of the data, both methods may be equally suited to portland-puzzolanic cements.

#### DESIGN OF JOURNAL BEARINGS

In this age of mechanical appliances many people are familiar with the construction of the ordinary journal bearing, namely, that it is a cylindrical shaft rotating in a cylindrical supporting sleeve. The average motorist realizes also that a supply of good lubricant is required for satisfactory bearing operation. To the man designing a bearing, however, it is necessary that he have

some knowledge of the factors that affect bearing performance. He must know, for example, that too high a load combined with too low a speed, or an oil that is too light, will cause failure because the metal surfaces will rub together and seize. On the other hand, with a combination of high load and high speed and an oil that is too heavy, the bearing may fail because the operating temperature is too high.

In a paper by Samuel A. McKee in the *Journal of Research* for October (RP1037) a method of journal-bearing design is described that takes into account both possibilities for failure, seizure, and high temperature. By the substitution of suitable values in an expression representing the rise in temperature of a bearing above its surroundings, two simple relations are obtained. These provide a means for the determination of the maximum loads and speeds permissible with a given oil under the conditions assumed for safety.

#### RUNNING-IN CHARACTERISTICS OF JOURNAL BEARINGS

As pointed out in the previous item, the operation and life of many valuable pieces of machinery are dependent upon the satisfactory performance of journal bearings. When properly designed and under suitable conditions the characteristics of the bearing metal are of minor importance in securing satisfactory performance, since the moving parts are supported by a film of oil. At best, however, this oil film is thin, and under adverse conditions it is reduced to the point where there is metallic contact between the surfaces of the bearing and journal. Under these conditions the characteristics of the bearing metal are a governing factor. Among the requirements significant in the choice of a bearing metal are mechanical strength, resistance to deterioration at operating temperatures, resistance to wear, low friction, and ability to be "run in" (become smoother with use).

In a paper to be published in the *Transactions of the American Society of Mechanical Engineers*, S. A. McKee and T. R. McKee describe an investigation of the running-in characteristics of journal bearings lined with three kinds of white-metal alloys. A four-bearing friction machine was used to determine the effect of progressive amounts of running in upon the frictional characteristics of the bearings. The results are compared with those of previous investigations, and all are in agreement in providing an indica-

tion that the major effect of running in is to reduce the friction losses under severe operating conditions and to increase the permissible operating range. The results also give a comparison of the frictional and running-in characteristics of the various metals.

#### GRAPHICAL COMPUTATION OF STRESSES FROM STRAINS

In recent years many investigations have been undertaken on the stress distribution in structural members in which the stresses have been computed from strain data. These investigations have been restricted usually to two-dimensional stress distributions.

In two-dimensional cases, where the directions of the two principal stresses (which are at right angles) are known, the computation of these stresses from measured strains in these directions and from the elastic constants of the material presents no difficulties. Frequently, however, the directions of the principal stresses are not known, as, for example, in the case of the web of a plate girder, and more than two strain components are required to determine completely the state of stress. In working on such problems, Ambrose H. Stang and Martin Greenspan, of the Bureau's engineering mechanics section, have found it convenient to determine the stresses from strains measured along four intersecting gage lines 45° apart, as a simple analytical solution is available for this case.

When the stresses are required at many locations the arithmetical computations become very tedious. In RP1034, in the *Journal of Research* for October, graphs are presented, the use of which materially reduces the time and labor involved in computation.

In structural design it is customary to work with normal and shearing stresses on certain sections—in the case of a beam, for example, the stresses on a cross section. The determination of such stresses from principal stresses is readily effected through the use of additional graphs presented in this paper.

#### FIRE TEST OF A BUILDING COLUMN

A steel building column encased with cinder-concrete blocks and gypsum plaster was recently tested at the Bureau for the School District of Philadelphia, Pa., to determine the fire-resisting value of this construction, the given type of column fireproofing not having heretofore been subjected to fire tests.

The column, a 6-in., 30-lb. H section, with a total length of 13 ft 1 in. and an

effective length of 10 ft 4 in., mounted with one end restrained and the other on a spherical bearing block, was subjected to a constant load of 59 tons throughout the test until failure occurred.

The block covering consisted of a shell of 3-in. hollow cinder-concrete blocks set in lime-portland-cement mortar, with a 1 1/4-in. space between the blocks and column flanges, which, together with the reentrant spaces between the column flanges, was filled solidly with cinder-concrete slabs and mortar. Including a 3/4 in. thickness of sanded gypsum plaster, the outside dimensions of the covering were 17 1/2% by 17 1/2% in.

The cinder concrete in the blocks weighed 84.6 lb/ft<sup>3</sup>, absorbed 15.5 lb of water per cubic foot, and had average compressive strength of 425 lb/in<sup>2</sup>. The combustible carbon content was 20 percent of the weight of the cinder concrete, and sulphur 0.3 percent, 0.1 as sulphur trioxide and 0.2 as sulphides.

The protected column, after being seasoned and dried to constant weight, was tested in a gas-fired furnace, the temperature of which was controlled in accordance with the time-temperature schedule of the Standard Specification for Fire Tests of Building Construction and Materials (American Standards Association A2, 1934). The expansion of the column reached its maximum at 6 hr 56 min, and failure to support the full applied load occurred at 7 hr 23 min. The measured temperature of the steel in the region of failure averaged 1072° F (578° C) when the column failed, the applied load being equivalent to an average stress of 13,200 lb/in<sup>2</sup> of the steel area. This temperature-load relation corresponds closely with those found in tests with small specimens of structural steel under closely controlled conditions, as reported in J. Research NBS 13, 713 (November 1934), RP741.

The plaster adhered to the cinder concrete over most of the area throughout the period of fire exposure, only a minor amount falling from the exposed corners. None of the block covering fell off.

Further information on the fire resistance of building columns is contained in the following Bureau publications, obtainable from the Superintendent of Documents at the prices indicated:

Fire tests of building columns, S. H. Inberg, H. K. Griffin, W. C. Robinson, and R. E. Wilson. Tech. Pap. BS 15, (1921) T184, 75¢.

Fire resistance of concrete columns. W. A. Hull and S. H. Inberg. Tech.

Pap. BS 18, 635 (1924-25) T272, 25¢.

Fire tests of columns protected with gypsum. N. D. Mitchell. BS J. Research, 10, 737 (1933) RP563, 5¢.

#### SIGNAL ENGINEERS TO MEET AT BUREAU

A meeting of the Signal Systems Materials Committee of the International Signal Association will be held at the Bureau on October 11, 1937. H. A. Friede, superintendent of fire alarm of the District of Columbia, is chairman of the committee. Comments and suggestions on specifications presented at the recent general convention of the Association will be considered prior to final printing.

#### CANS FOR FRUITS AND VEGETABLES

The first revision of the recommendation entitled Cans for Fruits and Vegetables (Names and Dimensions) has been accepted by manufacturers, distributors, and users of cans and became effective on September 1, 1937. The revised schedule is designated as Simplified Practice Recommendation R155-37.

The origin of this program dates to 1928, when the National Canners' Association requested the cooperation of the Bureau in making a survey of the canning industry for the purpose of ascertaining the diversity existing in sizes of packers' cans. The material thus secured, amplified by data obtained from the leading can producers, formed the basis for the simplified schedule of 27 sizes adopted by a general conference of all interests held on January 20, 1931. This list of 27 sizes was to take the place of the more than 200 sizes in existence at that time. The conference approved an effective date of July 1, 1931; however, because of delay in filing acceptances, changes in business conditions, and other reasons, the program was not made effective until September 1, 1934.

The current revision, which was approved on January 26, 1937, at a joint conference of the standing committee and other representatives of the canning industry and food distributors, effects a further net reduction of 6 sizes of cans and reduces the total number to 21 for stock purposes. These sizes range from 2 1/8 inches in diameter by 2 1/8 inches in height to 6 1/8 inches in diameter by 7 inches in height. The schedule also shows capacity of the cans in ounces of water at 68° F., can makers' description, and trade name.

In addition to the simplified list of can sizes, the revised printed issue will

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include a brief history of the development of this project, a list of the members of the standing committee, and a list of acceptors of the recommendation.

Until the printed book is available, free mimeographed copies may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

**NEW AND REVISED PUBLICATIONS  
ISSUED DURING SEPTEMBER 1937**

**Journal of Research<sup>1</sup>**

**Journal of Research of the National Bureau of Standards**, volume 19, number 3, September 1937 (RP1023 to RP1030, inclusive). Price, 25 cents. Obtainable by subscription.

**Research Papers<sup>2</sup>**

[Reprints from the July 1937 number of the *Journal of Research*]

**RP1007.** Some properties and tests of traffic or zone paints. Eugene F. Hickson. Price, 10 cents.

**Miscellaneous Publications<sup>1</sup>**

**M127.** Permeability of membranes to water vapor with special reference to packaging materials. Frederick T. Carson. Price, 5 cents.

**M158.** Evaluation of motion-picture film for permanent records. John R. Hill and Charles G. Weber. Price, 5 cents.

**Technical News Bulletin<sup>1</sup>**

**Technical News Bulletin** no. 245, September 1937. Price, 5 cents. Obtainable by subscription.

**MIMEOGRAPHED MATERIAL**

**Letter Circulars**

**Letter Circulars** are prepared to answer specific inquiries addressed to the National Bureau of Standards and are

<sup>1</sup> Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to *Technical News Bulletin*, 50 cents per year; *Journal of Research*, \$2.50 per year (United States and its possessions, and Canada, Cuba, Mexico, Newfoundland, and the Republic of Panama); other countries, 70 cents and \$3.25, respectively.

sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or to send copies automatically as issued.

**LC502B.** The durability of building papers and fiberboards relative to low-cost housing.

**LC502E.** Plumbing materials and equipment as related to low-cost housing.

**LC502F.** Investigation of low-cost floor coverings.

**Technical Information on Building Materials**

The supply of these notes, each of which consists of three or four pages giving the important facts on some one aspect of the properties or use of building materials, is necessarily limited. Their distribution will be confined to Government officials concerned with building projects, and to architects, engineers, and home builders. Requests should make clear the actual need for the information at the time of writing. Letters should be addressed to the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C. The following notes were issued since the list published in the September 1937 number of the Technical News Bulletin:

**TIBM-52.** Resistance of floor-covering materials to staining and chemicals.

**TIBM-53.** Adhesives for floor coverings.

**TIBM-54.** Relative resistance of floor-covering materials to abrasives.

**RECENT BUREAU ARTICLES APPEARING  
IN OUTSIDE PUBLICATIONS<sup>2</sup>**

Recent developments of the theory of turbulence. H. L. Dryden. *J. Applied Mechanics* (Am. Soc. Mech. Engrs., 29 West 39th St., New York, N. Y.) 4, A-105 (September 1937).

Nature of china clays. William W. Meyer. *Technical Association Papers* (Technical Assn. Pulp and Paper Industries, 122 East 42d St., New York, N. Y.), series 20, no. 1, 376 (June 1937).

<sup>2</sup> These publications are not obtainable from the Government. Requests should be sent direct to the publishers.



